SCIENTIFIC BOOKS.

RECENT BOOKS ON THE PHYSICS OF THE ELECTRON.

WHEN it is remembered that the physics of the electron had no recognized existence prior to 1896, that it was 1898 before the corpuscular theory of cathode rays, carrying with it the possibility of the divisibility of the atom, had gained general acceptance, and that it was 1902 before the first book appeared which pretended to treat, in any systematic fashion, the new class of experiments which have to do with atomic ionization, or disintegration, one can not suppress his astonishment at the magnitude of the book literature which exists today upon the general subject of the electron theory. The greater part of this literature is of a popular character, consisting in attempts at the simplification and demathematicization of the technical books and articles which the investigators themselves, for the most part, write. For this reason there is often so great similarity of treatment that neither the busy scientist nor the busy layman can read it all with profit. In fact the bewildering frequency of the appearance of new, popular books in this field leads a reviewer in *Nature* savagely to remark that 'the time is fast coming when the qualification which will play the most important part in determining a man's reputation as a physicist will be that he shall abstain from writing books on the philosophy of ether, matter and the universe.' For my own part, I do not believe that the popular exposition of true scientific knowledge can be overdone. Hence, so long as the authors of new books are true to the scientific spirit, and shun the inviting paths of pseudo-science, I welcome each addition to their ranks. Since, however, the multiplication of books upon the same theme necessitates a choice, the present collective review of the book literature of the electron theory is undertaken with the object of presenting a brief characterization of the most important of these books, with a view of aiding the student of physics, whether he be trained or untrained, in selecting those books which best meet his immediate needs.

It need scarcely be said that the book which is the fountain-head of all electron theory is J. J. Thomson's 'Conduction of Electricity through Gases' (Macmillan, 1893, pp. 1–560). Coming as it does from the pen of the man to whose genius and inspiration more than to that of any other one individual, the physics of the electron owes its origin and its development, the book is as truly epoch-making as any other which has appeared for a hundred years. The student who is thoroughly familiar with its content, and who has also read the same author's somewhat more popular Silliman lectures on 'Electricity and Matter' (Scribners, 1904, pp. 1–162, recently translated into German) is in fairly good touch with the electron theory as it exists to date. It should, however, be said that the discussion of the theory in its relation to metallic conduction finds no place in either of these books and that a few facts have been brought to light since their publication, such, *e. g.*, as Boltwood's proof of the long-suspected relationship between radium and uranium, which have slightly modified certain minor aspects of the theory. The two books together are needed in order to put the reader into intimate contact with J. J. Thomson's views; the former in order to give him, in most convenient form, both a complete review of the experimental data upon which the electron theory rests and the mathematical analysis which it involves; and the latter in order to give him a clear idea, unbefogged by mathematical symbolisms, of the physical pictures, the naked mechanisms, so to speak, which are at the bottom of the author's theoretical investigations. Both books, I take it, are too profound and too technical to be intelligible to the student who has not had thorough training in physics and mathematics; although both, and particularly the latter, may be read with partial understanding, and, therefore, with a certain measure of profit, by workers in other fields of science. These are the two books from which the popular expositors of recent views, from Oliver Lodge down, have drawn the greater part of their material and inspiration.

The only other book the scope of which is as broad as 'The Conduction of Electricity

through Gases' is Johannes Stark's 'Die Elektrizität in Gasen' (Barth, 1902, Leipzig, pp. 1–509)—a book which might have vied in value to the physicist with Thomson's had it not been rendered well-nigh worthless for reference purposes by the slovenly, unscientific and thoroughly un-German way in which references to original articles have been inserted. Like Thomson's book, it covers the whole field of gaseous ionization, whether produced by Becquerel or Roentgen rays, by light, by heat or by electric fields. It exhibits immense reading and profound scholarship. It is, in fact, a magnificent compendium of all the facts of gaseous conduction known at date of writing; but, unfortunately, these facts are so badly mixed up with the author's inferences from them that it is in general quite impossible to tell what is fact and what is inference. It is of the utmost importance that a scientific book, and particularly a book covering a new and speculative field should accompany each statement of fact with a statement of authority as is so admirably done in both Thomson's and Rutherford's recent books. The bewildering mass of references to original articles which Stark gives in connection with each general division of his book is practically worthless, because it is obviously impossible to search through all of them in quest of the verification of some particular statement of fact. In a word, then, a book which, with a little more labor and a little better arrangement, might have been an authoritative reference book for the physicist in a new field, is, instead, an elaborate and, on the whole, decidedly dogmatic presentation of one man's interpretation of recent discoveries—an interpretation which is in many instances questionable, and in some instances certainly erroneous, notably in its relation to induced radio-activity, the stumbling-block of most of the continental physicists. It is, nevertheless, a suggestive and valuable book for the student whose reading and discernment are wide enough to enable him to take at their proper worth its ex-cathedra statements.

Turning now to books of more limited scope, but still books written primarily for the physicist rather than for the general public, Rutherford's inimitable work on 'Radio-activity' (Cambridge University Press, 1904, pp. 1–397, and presently to appear in enlarged and revised form) should unquestionably be given first place. Since it is to Rutherford that the credit for the discovery of the real nature of radioactivity is almost wholly due, the subject having been in a state of hopeless confusion till he brought order out of chaos, his book will probably always stand as the most important contribution which this branch of the physics of the electron will ever receive. Although the author reveals himself in it as the advocate of a theory, he, nevertheless, never jumbles fact and theory as Stark does. In immediate connection with every assertion of fact is found a reference by which the assertion may be checked. From the standpoint of the serious and trained student of radio-activity the book is well-nigh above criticism, for it gives: (1) complete and convenient references to the whole literature of the subject; (2) a clear account of the methods used in the study of the subject; (3) a *résumé* of all the facts discovered to date; (4) a clear discussion of all these facts in the light of the disintegration hypothesis. With suitable revision this book will doubtless long be regarded by the student of radio-activity as his dictionary of the subject. Furthermore, since mathematical processes play a much less prominent rôle than in Thomson's book, and since the style is particularly lucid and interesting, even the general reader will find both interest and profit in its perusal.

A fifth book which every physicist should take an hour or two to read is a small volume of sixty-two pages by H. A. Lorentz, just issued (1905) by Julius Springer in Berlin, and entitled 'Ergebnisse und Probleme der Electronentheorie.' It is a very unpretentious book, being only the publication of a lecture delivered before the Berlin Electrotechnical Society. It contains, however, the first attempt with which I am familiar at a semi-popular treatment of the electron theory in its relation to metallic conductors, a subject

which, on account of its mathematical difficulty no doubt, has thus far received but little attention in the book literature of the electron theory. This pamphlet will be welcomed by all because it gives one of the foremost of the world's investigators upon the mathematical side of the electron theory an opportunity to state the results of his work and to present the present status of the theory from the standpoint of the mathematical physicist.

The last of the books which I shall mention as coming from the hands of the pioneer architects of the structure which we now call the physics of the electron, is the work of the now famous discoverer of radium, Madame Curie. Her thesis, entitled 'Recherches sur les Substances Radioactives' (Gauthier-Villars, Paris, 1904, pp. 1–154), is a plain, conservative record of the history of this discovery and of the most important results obtained by both herself and others in the study of radio-activity. The book, unlike Rutherford's, is uninspired and unillumined by any deep insight into the real nature of the phenomenon under investigation, but it has the inimitable charm of a simple, direct history of one of the world's greatest discoveries told in charmingly modest fashion by the discoverer herself.

To turn now from the books which are primarily for the physicist to the popular expositions of the work of the investigators, there are none of them which do not require for their intelligent reading some elementary knowledge of physics; and if such a book were written it would be too superficial to be in any true sense scientific, for it would have to confine itself to *conclusions* rather than to a presentation of *reasons* for conclusions, and such statements of conclusions are almost invariably misunderstood. Among the books, however, which purport to be written for the general public there are two which show great ability and are characterized by striking individuality. The first place is claimed, in my judgment, by Hon. R. J. Strutt's fascinating, popular treatment of 'Becquerel Rays and the Properties of Radium' (Edwin Arnold, London, 1904, pp. 1–214). This is the book to which I should first refer the non-physicist who wishes to begin the study of the newer investigations which center about the physics of the electron. The author says that his aim has been to give as clear and simple an account of radio-activity as the subject admits of without sacrificing accuracy. He has, therefore, divorced himself entirely from all mathematical modes of statement. He has, nevertheless, succeeded, to a surprising degree, in giving, in simple language, a clear idea of the train of discovery and reasoning which has led to recent conclusions. In the truest sense we popularize science only in so far as we succeed in putting it in such form that the layman can understand, not our conclusion simply, but, in a general way, the reasons for our conclusions also. This Strutt has succeeded in doing. While his treatment is popular, it thoroughly vigorous, scholarly, accurate and conservative, so that it may be unhesitatingly recommended, not only to the general reader who wishes to gain a correct idea of the latest aspect of scientific thought in this domain, but also to the physicist who wishes to gain a clearer vision of the naked physical ideas which are at the bottom of, and sometimes more or less beclouded by, the mathematical presentation of the electron theory.

The other of the two books above referred to is Robert Kennedy Duncan's new work, entitled 'The New Knowledge' (A. S. Barnes and Co., 1905, pp. 1–257). It is a book which will generally be criticized by physicists, I think, as being, to use the author's own adjective, a trifle too 'enthusiastic'—too Jules Vernesque in its implications at least, if not in its statements, to be classed as strictly scientific; and I myself fear that the untrained reader will lay it down with a somewhat erroneous impression of 'the new knowledge'—an impression that a certain quiet evolution which has been going on for the last decade in scientific thought is, instead, a tremendous revolution; that new discoveries have overturned the cornerstones of the old faith. As a matter of fact, in popular presentation, too much emphasis can not be laid upon the fact

that, while our knowledge has been greatly extended in recent years, not a single established doctrine has been upset. The doctrine of the indivisible atom never existed even with Dalton, the father of the atomic theory. A belief in the ultimate possibility of the transmutation of some at least of the elements has been held as firmly by modern scientists, from Faraday down, as by ancient alchemists. Even the doctrine of the conservation of mass in the strictest sense has not been held since Maxwell's time. I am a bit sorry, therefore, that Mr. Duncan does not take more pains to point out that the new discoveries supplement and extend established doctrines instead of setting them aside, and I am particularly sorry that in a book intended for the general reader and purporting to popularize *existing scientific views,* a chapter like that on 'the reconstruction of the universe' should have been introduced. In this chapter, which to my mind, mars a book which is otherwise valuable, despite its enthusiasms, the impression is given that modern discoveries have led us to suspect that *perpetual motion* may still be possible. As a matter of fact, in the light of all recent discoveries, there is not one iota more of probability that the second law of thermodynamics is invalid than there was before any of these discoveries had been made. In spite of these criticisms, and in spite of the fact that throughout the book speculation often wears the air of certitude, I wish to recommend it heartily, not so much to the general reader, for whom it is intended, as to the scientist. Every investigator whose work in a narrow field has limited his outlook will find it immensely suggestive and inspiring. Its author shows himself to be a man of wide reading, thorough scholarship, broad horizon and unmistakable literary talent. I do not find in it one single incorrect statement of fact. The features which differentiate it from books of its kind are: (1) its remarkably fine treatment of the periodic law in its relation to the divisibility of the atom; (2) its popularization of J. J. Thomson's *Philosophical Magazine* article on the constitution of the atom, a difficult but very successful piece of work; (3) its presentation of the bearing of celestial phenomena upon the hypothesis of the evolution of the elements; (4) its statement of Arrhenius's views as to the effect of light, pressure and corpuscular emission upon comets' tails, aurora borealis and other allied phenomena; (5) its capital concluding chapter on the validity of the new knowledge.

The remaining books which deal with the physics of the electron may be briefly mentioned in the order of importance. Frederick Soddy's 'Radio-activity' (The Electrician Printing and Publishing Co., London, 1904, pp. 1–214) is an attractively and ably written book, the outline of which coincides closely with that of Rutherford's, from which it differs chiefly in that it is considerably more elementary and popular. To those who find Rutherford's book a trifle too difficult this will be distinctly helpful.

A. Righi's 'Modern Theory of Physical Phenomena' (translated from the Italian by A. Trowbridge, Macmillan, 1904, pp. 1–165) is a very unpretentious but thoroughly wholesome little book written for the purpose of popularizing for the Italians recent scientific work done mainly by Anglo-Saxons. It devotes a relatively larger space to the discussion of electrolysis and the Zeeman effect than do most of the other popular books of the briefer sort.

Paul Besson's little book, 'Le Radium et la Radioactivité' (Gauthier-Villars, Paris, 1904, pp. 1–166), is written by the man under whose direction the work of extracting radium from pitchblende for the Curies was done. It is the only book upon the subject with which I am familiar which is addressed especially to medical men. The earlier portion follows very closely the outline of Mme. Curie's book, of which it is in fact but an abridgment and simplification, while the last half is devoted to a statement of the uses which radium has found in therapeutics.

Baskerville's 'Radium and Radioactive Substances' (Williams, Brown and Earle, Philadelphia, 1905, pp. 1–161) covers about the field of the last book, but differs from it in presenting more of Rutherford's work and

in bringing the therapeutic applications of radium up to 1905 instead of 1904.

Jacques Danne's 'Das Radium: Seine Darstellung und seine Eigenschaften' (Veit and Co., Leipzig, 1904, pp. 1–84) is a little book which those who wish to familiarize themselves with the chemical side of the extraction of radium from its ores may well consult.

Hans Mayer's 'Die Neueren Strahlungen' (Papanschek, Mähr Ostran, 1904, pp. 1–65) is a rather unsuccessful attempt to present in elementary fashion the theory of cathode, canal, Roentgen and Becquerel rays. It is not characterized by the usual German scholarship, for while it shows wide reading on the part of its author, it contains unpardonable oversights and blunders.

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UNIVERSITY OF CHICAGO,
November 16, 1905.

Principles of Physiological Psychology. By WILHELM WUNDT. Translated from the Fifth German Edition (1902) by EDWARD BRADFORD TITCHENER. Vol. I. London, Sonnenschein; New York, Macmillan. 1904. Pp. xvi + 347.

One can not but admire the industry and courage of Professor Titchener, who, in the midst of an exceptional productiveness of original text-books, ventures also on a translation of so ponderous and difficult a treatise as that of Professor Wundt on physiological psychology. The labor involved and the difficulty of achieving an adequate English version of this important work are, indeed, enormous, as pointed out in a personally interesting preface by the translator. If only the translation is successful in combining the qualities of good English and faithfulness to the original, the undertaking is certainly meritorious and much to be welcomed by readers who are not disposed to cope with the author's German further than is necessary. And, to judge by the present volume, the translation does in fact fulfil these requirements. It is as readable as could be hoped; in fact it is probably easier reading than the original, even though the reader should possess equal facility in both languages. The only reservation to be made on this score is that, as the translator has adopted the Wilder nomenclature for the nervous structures, most readers will need to familiarize themselves with a good number of new technical terms. It impedes the reader's progress to meet 'myel' for the cord, and 'cinerea' for the gray matter. Probably in this matter the translator chose to be a prophet rather than easily read. As to the faithfulness of the translation, here the reviewer's part becomes a serious one. Without pretending, however, to have compared every page of the English with the original, the reviewer can state that he has examined in detail the translation of various difficult passages, and looked up instances where the English suggested a possible error, and after all found only a few little slips. One or two rather obvious errors in the original have passed over into the translation, *e. g.*, at page 286, where, quite in contradiction with the context, the brain-weight of a full-grown orang-utan is given as only 79.7 grams.

A curious error appears in Fig. 79 and in the accompanying text on page 187. It was transferred from the original, and was apparently not passed by the translator without question. The figure purports to show the connection of the retinas with the cerebral hemispheres, but errs in connecting the right half of each retina with the left hemisphere, etc.; the nerve fibers from the nasal half of each retina are stated to pass to the brain without crossing, while those from the temporal halves cross—just the reverse of the truth. As the figure is credited to Vialet, the reviewer looked up Vialet's original figure, and found a rather complicated drawing, which had been simplified by Wundt. In the process of simplification, Vialet's diagrams of the retinas dropped out altogether, and their place was taken by some diagrams of the monocular fields of vision which Vialet had placed in front of each eye to show the crossed relation obtaining between the field of view and the retina, due to the crossing of the rays of light within the eye. Wundt's confusion of the retinas and the fields of vision in the figure led him to reverse the true relations in the text. The error is rather amusing—espe-

cially since another diagram of the same thing (Fig. 99), occurring in a later chapter, is correct—and it is made more so by a 'later note by author,' in which Wundt, whose attention had apparently been called to the discrepancy, while not recognizing the perversion of the figure and text, endeavors to slur over the contradiction in a straddling manner that has a curiously characteristic sound. There are a number of other errors in neurological details, though not by any means a large number. Wundt would of course not be the author to whom one would resort for a knowledge of nervous anatomy and physiology, with which the present instalment of the translation is concerned. The value of this portion of the work lies in the author's broad, if somewhat speculative, views on the general principles of the structure and functions of the nervous system.

The translator has thoughtfully provided a special index for this volume.

R. S. WOODWORTH.

COLUMBIA UNIVERSITY.

SCIENTIFIC JOURNALS AND ARTICLES.

THE contents of *The Journal of Comparative Neurology and Psychology* for November is as follows:

CLARENCE LOEB: 'Some Cellular Changes in the Primary Optic Vesicles of Necturus.'

RAYMOND PEARL: 'Some Results of a Study of Variation and Correlation of Brain Weight.'

A. H. ROTH: 'The Relation Between the Occurrence of White Rami Fibers and the Spinal Accessory Nerve.' (With an Addendum by J. Playfair McMurrich.)

JOHN E. ROUSE: 'Respiration and Emotion in Pigeons.'

JOHN B. WATSON: 'The effect of the Bearing of Young upon the Body-Weight and the Weight of the Central Nervous System of the Female White Rat.'

The Work of Carl Wernicke.

H. S. JENNINGS: 'Papers on Reactions to Electricity in Unicellular Organisms.'

SOCIETIES AND ACADEMIES.

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES.

There will meet at New Orleans:

The American Association for the Advancement of Science.—The week beginning on December 28. Retiring president, Professor W. G. Farlow, Harvard University; president-elect, Professor C. M. Woodward, Washington University, St. Louis, Mo.; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Professor C. A. Waldo, Purdue University, Lafayette, Ind.; secretary of the council, Dr. John F. Hayford, U. S. Coast and Geodetic Survey, Washington, D. C.

Local Executive Committee.—Honorary president, President E. B. Craighead, Tulane University; executive president, Professor George E. Beyer, Tulane University; secretary, Henry M. Mayo, The New Orleans Progressive League; treasurer, Mr. Clarence F. Low, of the Liverpool, London and Globe Insurance Company.

Section A, Mathematics and Astronomy.—Vice-president, Dr. W. S. Eichelberger, U. S. Naval Observatory, Washington, D. C.; secretary, Professor L. G. Weld, University of Iowa, Iowa City, Iowa.

Section B, Physics.—Vice-president, Professor Henry Crew, Northwestern University, Evanston, Ill.; secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Section C, Chemistry.—Vice-president, Professor Charles F. Mabery, Case School of Applied Science, Cleveland, Ohio; secretary, Professor Charles L. Parsons, New Hampshire College of Agriculture, Durham, N. H.

Section D, Mechanical Science and Engineering.—Vice-president, Professor F. W. McNair, Houghton, Mich.; secretary, Professor Wm. T. Magruder, Ohio State University, Columbus, Ohio.

Section E, Geology and Geography.—Vice-president, Professor Wm. North Rice, Wesleyan University, Middletown, Conn.; secretary, Dr. Edmund O. Hovey, American Museum of Natural History, New York, N. Y.

Section F, Zoology.—Vice-president, Professor Henry B. Ward, University of Nebraska, Lincoln, Nebr.; secretary, Professor C. Judson Herrick, Denison University, Granville, Ohio.

Section G, Botany.—Vice-president, Dr. Erwin F. Smith, U. S. Department of Agriculture, Washington, D. C.; secretary, Professor F. E. Lloyd, Teachers College, Columbia University, New York, N. Y.

Section H, Anthropology.—Vice-president, Dr. George Grant MacCurdy, Yale University, New Haven, Conn.; secretary, George H. Pepper, American Museum of Natural History.

Section I, Social and Economic Science.—Professor Irving Fisher, Yale University, New Haven, Conn.; secretary, Dr. J. F. Crowell, Bureau of Statistics, Washington, D. C.